PROVIDENCE SEWAGE TREATMENT SYSTEM
Providence
Providence County
Rhode Island

HAER No. RI-20

~~PHOTOGRAPHS~~

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Mid-Atlantic Region
National Park Service
Department of the Interior
Philadelphia, Pennsylvania 19106

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PROVIDENCE SEWAGE TREATMENT SYSTEM

HAER NO. RI-20

LOCATION:	Providence, Providence County, Rhode Island
DATES OF CONSTRUCTION:	1895-1901; 1912-13; 1930-34
ENGINEERS:	J. Herbert Shedd, Otis F. Clapp, S. Frank Nolan
PRESENT OWNER:	Narragansett Bay Commission 44 Washington Street Providence, Rhode Island
SIGNIFICANCE:	The Providence sewage treatment system is significant among a variety of public services and utilities developed in the city, beginning after the Civil War, to improve environmental conditions or to facilitate or enhance community growth. Initially conceived in the 1880's, Providence's first sewage treatment facility, utilizing the chemical precipitation process, was constructed at Fields Point between 1895 and 1901, and was the largest of its kind built in the U.S. During the 1930's, the Fields Point plant was extensively reconstructed so that sewage could be treated by the activated sludge method. The system was proposed by Samuel Gray, largely designed under J. Herbert Shedd, and brought to completion under Otis F. Clapp. S. Frank Nolan supervised the remodeling of the Fields Point plant in the 1930's. The nine properties documented in this report illustrate important aspects of the evolution of sewage treatment in Providence during the system's first forty years.
PROJECT INFORMATION:	The historic resources of the Providence sewage treatment system were recorded January-April 1989 by the Cultural Resource Group of Louis Berger & Associates, Inc. for the Narragansett Bay Commission, Providence, and the U.S. Environmental Protection Agency.

The work was performed in accordance with a memorandum of agreement between the EPA, Bay Commission and Rhode Island State Historic Preservation Office. The project team consisted of Martha H. Bowers, Architectural Historian; Rob Tucher, Photographer; and Anthony Masso, Draftsperson.

I. GENERAL DESCRIPTION

The subjects of this documentation are nine historic properties associated with the development of sewage treatment facilities in Providence, Rhode Island, during the period 1895 to 1935. Constructed under the auspices of the City of Providence, these properties are now under the jurisdiction of the Narragansett Bay Commission, an agency created by the Rhode Island General Assembly in 1980.

The nine properties are all located in the southern portion of the City of Providence. Three (engine house, filth hoist house and boiler house) are features of the main sewage pumping station, situated on Ernest Street at Allens Avenue. Two are individual pumping stations (Washington Park Pumping Station and Reservoir Avenue Pumping Station) which pump sewage from low-lying neighborhoods. The remaining four properties (chemical building, sludge press house, laboratory and return sludge pumping station) are contained within the sewage treatment plant at Providence's Fields Point on the west side of the Providence River, which empties into Narragansett Bay. These nine properties were integral components of a system for conveyance and treatment of sewage begun after the Civil War. During the century that has passed, the system has experienced almost continuous change, through adoption of new processes and construction of new facilities designed to meet the expanding needs of the City of Providence and much of the Providence metropolitan region. The evolution of the system is reflected in the histories of the nine structures: two (the boiler house at the Ernest Street Pumping Station, and the laboratory at Fields Point) are no longer extant; three (the engine house and filth hoist house at Ernest Street, and the chemical building at Fields Point) are currently undergoing rehabilitation for new uses.

II. HISTORICAL DISCUSSION

A. Background

[Note: This background section has been developed from Woodward and Sanderson's Providence: A Citywide Survey of Historic Resources (1986).]

The initial development of a sewage collection and treatment system occurred against a background in which the city of Providence emerged as a major industrial center during the decades after the Civil War. Settled in 1636 under Roger Williams, Providence developed in the 17th century as an agrarian community, the bulk of its small population located on the east side of the Providence River on house lots purposely long and narrow to provide each owner with direct river access. During the 18th century, Providence's strategic location at the head of a natural harbor enabled the town to transform both its economy and its built environment through participation in a variety of maritime activities, including the North American coastal trade, trade with Britain, and the triangular trade among North America, Africa and the Caribbean. Ironically, this century also saw substantial reduction in Providence's town limits, which until 1730 included all of present-day Providence County west of the Blackstone River. Although the community had expanded to the west bank of the Providence River and increased its population, the General Assembly began to set off former Providence lands as new towns in 1731, eventually reducing the town's limits to about 6 square miles.

The maritime economy of Providence suffered under British regulations enforced on all the colonies in the 1760's and 1770's, but prospered during the Revolution by supplying the needs of both American and French navies, and through privateering against British cargo vessels. Emerging from the war with its "ships, fortunes and merchant ranks intact" Providence achieved still greater heights of prosperity as a maritime community in the closing decades of the century.

In 1790, however, the first factory spinning of cotton yarn was achieved at Pawtucket. By the first decade of the 19th century Providence's financial interests began to shift their attention, and investments, toward industry, most at first located in Providence County but on water privileges outside the town. Continued population growth within Providence made it the seventh largest community in the U.S. in 1810, but it remained under the traditional town-meeting form of government until 1832. Incorporated as a city that year, Providence was thus provided with the administrative structure necessary to oversee its second and most enduring transformation, from seaport town (although it retained many of these activities) to a major industrial center. Much of the labor force of this new industrial base was derived from immigration: from Britain and Canada and Ireland prior to the Civil War; after the Civil War primarily from Italy, and also Portugal, French Canada, Russia, Sweden, Turkey and Germany.

During the 80 years between the Civil War and World War II, historical development of Providence was characterized by a tremendous intensification of the patterns of urbanization and industrialization that had emerged in the second quarter of the 19th century. After the Civil War, its major industries (metals, jewelry and textiles) increased their dominance of the local economy, augmented by significant production of electrical supplies, rubber goods, silk and innumerable other products. This expanding industrial base rested on an equally-expanding population: between 1865 and 1880, Providence's population doubled, then doubled yet again by 1910 (accounting for most of the 450% increase over the period as a whole). During the resulting building boom, nearly 30,000 dwellings were constructed. Housing and industrial development expanded to remaining rural areas on the inner edges of the city limits, and threatened to advance well beyond. In response, the city re-annexed portions of adjacent towns originally set off in the 18th century: parts of Cranston (1868, 1892), North Providence (1873, 1874) and Johnston (1989, 1919).

Although engineered primarily by private enterprise, the explosive growth of late 19th century Providence relied upon, and was facilitated by, the development of a variety of public services and utilities (among them sewage treatment) that provided the important "infrastructure" necessary for the functioning of an industrial metropolis. A municipal water supply was developed, with three major reservoirs constructed between 1868 and 1899. Providence Telephone was incorporated in 1879, and limited electrical service was available in the city by 1882. Providence's public transit system, inaugurated in 1865 with horsecars, was converted to electric trolley service by the early 1890's. The city funded the improvement of numerous streets, and constructed Blackstone Boulevard (1892-4) and Pleasant Valley Parkway (1909) to provide additional incentive for development and improve access for increasing numbers of commuters.

B. History of Sewage Treatment in Providence

The growth (numerically, geographically and industrially) that necessitated and benefited from these improvements (as well as an improved "social infrastructure" in the form of schools, fire and police protection) also resulted in increasing amounts of household and industrial waste, a problem which the city was forced to address soon after the Civil War.

The initial approach to the sewage issue in Providence was focused rather directly upon collecting household and industrial waste and depositing it into the rivers and harbor. There it was assumed that dilution and natural processes (not then fully

understood) would render it harmless, or at least take it out of harm's way. In 1869 the City passed an ordinance providing for public construction of sewers, a task subsequently delegated to a Board of Water Commissioners organized in 1873. The Board entrusted the specific planning of a sewer system to Joel Herbert Shedd, then City Engineer and previously architect of Providence's water supply system (National Cyclopaedia of American Biography, vol 13, p. 44). Reporting to the Board in 1874, Shedd observed that "the amount of impurity from our sewers is so small, when compared to the volume of water in the harbor," that the practice of dumping raw waste presented "no great inconvenience." However, Shedd also warned that "it is probable...there will be, before many years, an imperative popular demand for the purification of sewage before its discharge into rivers and harbors" (Shedd 1874:13, 14).

Within a decade, the tremendous population and industrial growth of Providence had proved Shedd correct. Recognizing the need for a system for treating household and industrial waste, but unsure what the proper method should be, the City Council in Spring, 1884, authorized the City Engineer to travel to Europe, then in the forefront of developments in sanitary engineering. The purpose of the trip was to investigate sewage treatment methods in use in major cities at the time, and from those investigations propose recommendations for sewage treatment in Providence.

The City Engineer at that time was Samuel Gray (1842-1921). In 1869, following his work as chief engineer for construction of a water supply system in Hartford, Connecticut, Gray had joined Herbert Shedd as assistant engineer on the Providence water supply system then under construction, with principal responsibility for Sockanossett and Hope reservoirs. Gray succeeded Shedd as Providence's City Engineer in 1877 (National Cyclopaedia of American Biography, Vol. 19, pp. 175-76).

Upon his return to Providence, Gray prepared a report for the Board of Water Commissioners, submitted in the late months of 1884 (Gray 1884). In this report, Gray recommended that the city construct a system of interceptors by which sewage would be collected from neighborhood sewer lines and conveyed to Fields Point, a small peninsula on the west bank of the Providence River, which was at the time the site of an abandoned military fortification, a smallpox hospital, and a few dwellings. At Fields Point, Gray proposed development of a treatment plant that would process sewage by the chemical precipitation method. Precedent existed for the use of this method, primarily in England, where it was in widespread use during the period of Gray's European investigations (Keefer 1940:137).

Unlike plain sedimentation, the process by which suspended matter in sewage was settled out simply by gravity, the chemical precipitation process involved introduction of one or more soluble chemicals to produce a floc, or coagulant. The floc adsorbed, or "enmeshed and carried down" the solids in the sewage. A variety of chemicals could be employed to generate the floc, including aluminum sulfate, ferrous sulfate and lime; lime alone, or ferric sulfate or ferric chloride with or without lime. Use of such coagulants resulted in removal of a higher percentage of suspended solids than did plain sedimentation. However, the resulting volume of sludge could be significantly reduced by the use of presses, which Gray noted had been "perfected recently in England", to remove excess liquid, leaving cakes of solid matter for disposal (Hardenbergh 1946:284ff; Keefer 1940:138ff; Gray 1884:100).

Gray's proposal was eventually implemented as the "Improved Sewerage System" authorized by the City Council in 1890. Construction of the interceptors began within a year under J. Herbert Shedd, who had resumed the position of City Engineer following Samuel Gray's resignation to enter private practice. Under Shedd's direction, the overall plan of the plant at Fields Point was developed along with designs for the precipitation tanks and the pump station planned for Ernest Street, by which sewage from low-lying areas of the city would be lifted into an 88-inch main and conveyed into the treatment plant (Narragansett Bay Commission, Drawing Files).

Otis Clapp succeeded Shedd as City Engineer in 1898 (although Shedd continued to participate for at least two more years as a consulting engineer). Under Clapp, the Fields Point laboratory, chemical building, and sludgepress house were designed and built (Narragansett Bay Commission, Drawing Files). The plant was put into operation in April 1901, with Julius W. Bugbee, formerly associated with the precipitation plant at Worcester, Massachusetts, as Superintendent and Chemist (Providence, City Engineer 1901:40). Providence's chemical precipitation plant was subsequently described as "the largest of its type ever built" in the United States. Its most noteworthy predecessors were the precipitation plant at Worcester, put in operation in 1890, and the precipitation plant at East orange, New Jersey, its 1888 date making it the first city-built chemical precipitation works in the country (Engineering News 1931; Keefer 1940:154).

The operation of Providence's new sewage treatment plant was excellently presented in the City Engineer's annual report for the year 1900:

The sewage, previously freed of the coarsest part of the floating matter, by screens at and near the [Ernest Street] pumping station, flows thence to the tanks... through the 88-inch conduit...Opposite the Chemical Building...the 88-inch conduit enlarges to a semi-circular open mixing channel 150 feet long, and 16 feet wide. In this channel are placed slate stone baffle plates, set six feet apart on alternate sides, and lapping by each other 12 inches. Just above the entrance to this channel the chemical in solution enters the 88-inch conduit by the drain from the Chemical House, and mingles with the sewage. The whole then passes through this channel, becoming thoroughly mixed in its course by the baffle plates, before reaching the entrance gates of the roughing tanks....

Having entered a roughing tank, where the coarsest and heaviest material will probably be precipitated, the partially cleared effluent passes over the weir on the side of the tank opposite the entrance, into the channels leading to the main distributing channels... whence it is admitted through 16-inch gates into the finishing tanks....When a tank is filled, the effluent passes in a thin sheet, over the weir at the opposite end of the tank, and falls into the effluent channels running north and south. The effluent from the eastern tanks flows through these channels directly to the effluent well, where it passes into the effluent outfall sewer, and thence to the outlet at Fields Point, while that from the western tanks reaches the well through a covered effluent channel running east and west through the central structure...

When the effluent is drawn down to the surface of the sludge the gate is shut, the sludge gate at the corner of the tank is opened, and the sludge flows through the channels in the corridors to the sludge well where it passes through the screens. From here it is pumped or forced by the ejectors up into the sludge reservoirs [situated outside the north wall of the Sludge Press House], where...it is allowed to settle for some time...The sludge flows from these reservoirs into the forcing receivers [inside the Sludge Press House] by gravity. Air compressed to from 80 to 100 pounds pressure is then applied and the sludge forced up into the presses. The liguid is returned to the tanks for treatment, and the sludge cakes dropped into cars and carried away, to be used for filling or as fertilizer... (Providence, City Engineer 1901:48-50).

Within a decade of its proud opening, however, Providence's sewage treatment plant began to experience problems. During the first years of operation, sludge generated at Fields Point was carried away for use as fill or fertilizer; subsequently, it was taken by barge and dumped into Narragansett Bay. The chemical precipitation process itself produced a large volume of sludge, relative to other methods, and the continuing growth of Providence (and of its household and industrial wastes) began to put severe pressures on the 30 mgd capacity of Fields Point. In 1910 the practice of dumping sludge into the bay become a public issue when bay oystermen, through their champion, Prof. Frederick Gorman of Brown University's bacteriological laboratory, raised complaints about the effects of sludge dumping on their oyster beds (Providence Journal, 10 December 1910:16). Perhaps as a temporary response, the use of chemicals at Fields Point was suspended during 1911 and 1912 (thus operating by the plain sedimentation method) (Engineering News 1931:181).

Although the issue of dumping sludge in the bay was not immediately resolved, the oystermen's laments may have contributed to the introduction, in 1914, of a bill in the state's General Assembly proposing the creation of a metropolitan sewerage commission. The City of Providence raised vociferous objections, suggesting that what was actually required was more effort on the part of other communities on Narragansett Bay, rather than establishment of a metropolitan sewerage system (Providence Journal 19 February 1914:3). Although this bill failed to pass, the issue remained alive, and was revived again in 1921 with the proposed Metropolitan Sewerage Act. This act simply called for a committee to investigate the region's sewerage problems; however, the City of Providence moved swiftly once again to denounce the measure, basing its arguments on what it perceived as a lack of appropriate city representation on the proposed sewerage commission (Providence Journal, 22 April 1921:1).

In 1919-1920, the Fields Point plant again suspended use of chemicals (although lime bleach continued to be used as a disinfectant) (Engineering News 1931:181). By the mid-1920's, the continued and increasing inadeguacy of the Fields Point plant led the City Council to an investigation of alternatives, and to the Commissioner of Public Works' admission, in the Providence Journal, that the facility was fundamentally obsolete (Providence Journal, 14 November 1926:7). In truth, the chemical precipitation process, as developed in Great Britain and adopted by a very few U.S. cities (Worcester and Providence being the most prominent) had proved a rather unsatisfactory method of treatment, due not only to the large amount of sludge produced, but also to the high cost of chemicals. As other methods were developed, use of the chemical precipitation process, never extensive in the U.S., declined significantly between 1910 and

1930 (although with improved technology, plus a decrease in the price of chemicals, it experienced a revival in the 1930's) (Keefer 1940:138). With this in mind, the Joint Standing Committee on Sewers of the Providence City Council in 1925 conducted a tour of eight U.S. cities to learn more about sewage treatment methods that might be used to prevent, or at the very least decrease, pollution in the harbor and Bay.

The process viewed with most enthusiasm by the Committee was that of activated sludge, then "the latest development in sewage disposal" (Joint Standing Committee 1926:12). In this process, sewage was first passed through primary settling tanks, in which larger solids were removed. It then flowed to aeration tanks, where it was mixed with biologically active sludge and with oxygen provided by compressed air. The activated sludge contained bacteria which, with the introduction of air, oxidized organic matter in the sewage. After aeration, the sewage flowed to final clarifiers or settling tanks, where the sludge settled out and the effluent was channeled off. A portion of the activated sludge was returned into the treatment process to replenish the supply of bacteria, and the rest was dewatered and removed for disposal (Hardenberg 1946:297-298).

As a result of the City Council's investigation, the decision was eventually made to convert the Fields Point plant from the chemical precipitation process to the activated sludge process. Although planning began in the late 1920's, most of the actual work was accomplished between 1930 and 1934, under the supervision of City Engineer S. Frank Nolan (Providence Journal, 21 August 1929:12; Anderson-Nichols & Co. 1979:IX:1; Engineering News 1931:181; Nolan 1931:25ff). Nolan (1874-1954) joined the office of the City Engineer as a rodman in the 1890's, subsequently serving as maintenance supervisor of waterworks (1920-27) and as City Engineer from 1927 until his retirement in 1946 (National Cyclopaedia of American Biography 1963:565). Nolan, assisted by deputy city engineer Horace Almy, assistant city engineer Walter Kendrick, and Julius Bugbee, developed plans by which parts of the existing treatment facility could be "transformed economically" into elements of the new activated sludge system, thereby realizing "considerable saving" over the cost of completely new construction (Nolan 1931:63). Thus, one chemical precipitation basin was converted to a pre-aeration tank, three were rebuilt as primary settling tanks, and sixteen were converted into thirty-two aeration tanks. The Chemical House was cleared of its bins and tanks and remodeled for the installation of blowers (originally three, with two more added later) which would supply the compressed air integral to the new system. New construction included two screen chambers, two grit chambers, five final settling tanks, and a pumping station through which a portion of the activated sludge would be returned

to the treatment process (Anderson-Nichols & Co. 1979:IX-1; Nolan 1931:63; Providence Department of Public Works 1932).

In the remodeled plant, as described by Nolan (1931:27), raw sewage was first passed through two mechanically-cleaned screens to 55-foot square grit chambers, or detritors, where grit and other heavy solids were removed. The sewage then progressed to two primary settling tanks, equipped with revolving sludge scrapers. The effluent from these tanks then passed through a mixing channel, where biologically active sludge was introduced. In the aeration tanks, air was introduced by means of the blowers to aerate and agitate the sewage. Effluent from the aeration tanks was clarified, by simple sedimentation, in the five final settling tanks, then released into the Providence River. The sludge not returned into the process was dewatered, as in the earlier chemical precipitation process, by the filter presses. The total capacity of the new plant was 50 million gallons of sewage per day.

Despite the extensive remodeling of Providence's sewage treatment plant, the opinion remained in some quarters that the problems of pollution in the harbor required a metropolitan solution. In the late 1930's, a $427 million public works program was proposed by the state's Democratic administration (to be augmented, if approved, with a 45% matching grant from the federal Public Works Administration). The proposed program included $12 million instate funds for a metropolitan sewerage system. The proposal was "decisively" defeated in the November, 1938 referendum, not only in other cities besides Providence which had their own sewage treatment systems, but also in communities "which had been promised the greatest benefits" (Providence Journal, 9 November 1938:1).

In subsequent decades, the Fields Point plant experienced almost continuous remodeling. Between 1946 and 1949, the sludge storage tanks were remodeled, old sludge presses were replaced with eight modern vacuum filters, a multiple-hearth incinerator was built between the Sludge Press House and Blower Building (formerly the Chemical House), fed by means of a conveyor system, and facilities for chlorination of the final effluent were installed. Then in 1955-56, the step-aeration process (originally developed for the New York City sewage treatment system) was introduced at Fields Point. Work under this program included construction of a new grit building, two new primary settling tanks and a primary sludge pumping station; remodeling of the existing aeration tanks, pre-aeration tanks and a primary settling tank into ten aeration tanks; addition of two more blowers; construction of two circular final settling tanks; and (in 1959) erection of a large new addition to the laboratory building. The eight vacuum filters installed during the 1940's were replaced in two stages,

with a large coil vacuum filter installed in 1959-60 and two smaller units in 1963 (Anderson-Nichols & Co. 1979:IX-3).

In the end, a metropolitan solution to the pollution of the Providence River and Narragansett Bay was not implemented until the creation of the Narragansett Bay Commission in 1980. That year, the Rhode Island General Assembly authorized the formation of the Narragansett Bay Commission, to operate and maintain Fields Point and a sewage collection system for the Providence metropolitan area, and to "rehabilitate, rebuild and modernize" those facilities. The Bay Commission took over Fields Point, the Ernest Street, Washington Park and Reservoir Avenue pumping stations, plus 45 miles of sewer interceptors, 32 tide gates, and 64 combined sewer overflows in 1982. Since that time, Fields Point has experienced almost complete reconstruction under the guidance of the U.S. Environmental Protection Agency (Narragansett Bay Commission 1986).

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